

**80/282/CDV****COMMITTEE DRAFT FOR VOTE (CDV)
PROJET DE COMITÉ POUR VOTE (CDV)**

		Project number Numéro de projet		80/16273 (joint ISO/IEC project)	
IEC/TC or SC: 80 CEI/CE ou SC:		Date of circulation Date de diffusion 2001-01-12		Closing date for voting (Voting mandatory for P-members) Date de clôture du vote (Vote obligatoire pour les membres (P)) 2001-06-15	
Titre du CE/SC:			TC/SC Title: MARITIME NAVIGATION AND RADIOCOMMUNICATION EQUIPMENT AND SYSTEMS		
Secretary: M. Rambaut United Kingdom Secrétaire:					
Also of interest to the following committees Intéresse également les comités suivants ISO TC 8/SC 6			Supersedes document Remplace le document 80/259/CD		
Horizontal functions concerned Fonctions horizontales concernées					
<input type="checkbox"/> Safety Sécurité		<input type="checkbox"/> EMC CEM		<input type="checkbox"/> Environment Environnement	
				<input type="checkbox"/> Quality assurance Assurance qualité	

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Title :

ISO/IEC 16273: Ships and marine technology - Night vision equipment for high speed craft - Operational and performance requirements, methods of testing and required test results

Introductory note: IEC/ISO 16273 has been developed jointly by IEC TC 80 and ISO TC8/SC6. ISO have taken the administrative lead and circulated the draft CD texts as ISO 16273. TC 80 have made comments on these drafts. It has been agreed by the IEC and ISO Central Offices that this project should be published by ISO as ISO/IEC 16273.

The IEC CDV stage is equivalent to the ISO DIS stage. This document will now be circulated in parallel as a CDV in IEC and as DIS in ISO. Members of IEC TC 80 are invited to comment and vote in the normal manner. For those members who are also members of ISO TC8/SC6 it would be appreciated if their comments and vote are identical to those made to IEC TC 80.

After completion of the voting, the Secretariats of IEC TC 80 and ISO TC8/SC6 will resolve the comments, with the assistance of experts if necessary. The amended text will be circulated as FDIS in IEC and ISO.

This CDV is circulated as an English only document.

Contents

1	Scope.....	1
2	Normative references.....	1
3	Definitions.....	1
4	General and operational requirements.....	2
5	General test conditions.....	7
6	Environmental tests.....	7
7	Laboratory tests.....	8
8	Sea Trials.....	11
	Annex A (informative) Range prediction calculation.....	14
	Annex B (informative) Infrared illuminators, typical plots.....	16
	Annex C (informative) Sea trial record.....	17

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 16273 was prepared by Technical Committee ISO/TC 8, *Ships and marine technology*, Subcommittee SC 6, *Navigation*.

This second/third/... edition cancels and replaces the first/second/... edition (), [clause(s) / subclause(s) / table(s) / figure(s) / annex(es)] of which [has / have] been technically revised.

Ships and marine technology — Night Vision Equipment for High Speed Craft — Operational and performance requirements, methods of testing and required test results

1 Scope

This International Standard ISO 16273 applies to night vision equipment fitted to high speed craft in accordance with the International Code of Safety for High Speed Craft (HSC code), Chapter 13, of the International Maritime Organisation (IMO) and the IMO performance standards MSC ... (72) for night vision equipment for HSC.

All texts of this standard, whose wording is identical to that in IMO MSC ... (72) are printed in italics and the resolution and paragraph numbers are indicated in brackets.

2 (IMO MSC ... (72) 3) Normative References

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All normative documents are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 61162: *Maritime Navigation and Radiocommunication Equipment and Systems – Digital Interfaces.*

IEC 60945: *Maritime Navigation and Communication Equipment and Systems – General Requirements – Methods of Testing and Required Test Results.*

IMO Res. A.694 (17): *General Requirements for Shipborne Radio Equipment forming Part of Global Maritime Distress and Safety System (GMDSS) and for Electronic Navigational Aids.*

IMO Res. A.830 (19): *Code on alarms and indicators.*

IMO Res. MSC ... (72): *Performance standards for night vision equipment for high speed craft (HSC).*

International Code of Safety for High Speed Craft (HSC Code).

3 Definitions

For the purposes of this International Standard, the following definitions apply:

3.1 (IMO MSC ... (72) 4) night vision equipment

any technical fixed means enabling the position and aspect of objects above the water surface relative to one's own craft to be detected at night

3.2 (IMO MSC ... (72) 4) high-speed craft

any craft to which the definition in chapter 1 of the HSC Code applies

3.3 (IMO MSC ... (72) 4) test target for sea trials

a target that simulates the real hazard of a surface object that can be found at sea such as, small unlit boats, floating logs, oil drums, containers, buoys, ice, hazardous waves and whales

3.4 lit vessel

a vessel that in addition to the standard navigation lights has a row of five 21 Watt, 12 Volt unshielded lamps at one meter horizontal spacing and four meters above sea level

4 General and operational requirements

4.1 Introduction

Requirements contained in this clause 4 are requirements not taken up in other clauses and which cannot be verified by repeatable methods of measurement.

These requirements include the applicable general and operational requirements of IEC 60945.

The manufacturer shall declare compliance with these requirements and shall provide relevant documentation. The declarations, documentation and where necessary, the equipment under test (EUT) shall be checked.

The manufacturer shall also declare the composition of the EUT and the category for durability and resistance to environmental conditions specified in IEC 60945 for each unit of the EUT.

4.2 (IMO MSC ... (72) 5.1) Required functions and their availability

At night, night vision equipment shall be capable of detecting objects above the water's surface within a certain distance from one's own craft, and of displaying the information pictorially in real time, to assist in collision avoidance and safe navigation.

4.3 (IMO MSC ... (72) 5.2.1) Continuous operation

Night vision equipment on board HSC, while navigating at sea, shall be capable of continuous operation from after sunset until before sunrise. After the equipment has been switched on it shall be operational in less than 15 minutes.

4.4 (IMO MSC ... (72) 5.2.2) Standard test target

The standard test target shall be a black metal target of such a size that when at least 50 % is immersed, 1,5 m long and 0,5 m high remains above the water at right angles to the desired direction of detection. Administration may use other smaller targets to reflect local conditions.

4.5 (IMO MSC ... (72) 5.2.3) Detection range

With the required field of view, the equipment shall detect the standard test target at a distance of not less than 600 m with a minimum probability of 90 %, when the target has been immersed in the sea for at least 24 hours under mean starlight conditions without clouds and without moon.

4.6 (IMO MSC ... (72) 5.2.4) Field of view

The required horizontal field of view shall be at least 20°, 10° on either side of the bow. The vertical field of view shall be at least 12° and shall be sufficient to enable the equipment to fulfill the performance requirements of this standard as well as being able to see the horizon.

Optionally other fields of view may be provided. Their selection shall be made with a non-locking switch, which returns to the required field of view when released.

4.7 (IMO MSC ... (72) 5.2.5) Pan and tilt ranges of the fields of view

The axis of the field of view of the equipment shall be capable of being moved at least 20° horizontally to either side.

The elevation axis of the field of view shall be capable of being adjusted of at least 10° to compensate for the trim of the craft.

4.8 (IMO MSC ... (72) 5.2.6) Speeds of panning of the fields of view

By activation of a single control element, the axis of the field of view shall be capable of being returned automatically to the ahead position at a minimum angular speed of 30°/s. The system shall be capable of panning at a minimum angular speed of 30°/s.

4.9 (IMO MSC ... (72) 5.2.7) Heading marker indication

When inside the field of view, the graphical ahead mark of the craft shall be indicated on the display with an error not greater than $\pm 1^\circ$.

When outside the field of view, a visual indication of relative bearing with an error not greater than $\pm 1^\circ$ shall be provided.

4.10 (IMO MSC ... (72) 5.2.8) Roll or pitch

The performance of the night vision equipment shall be such that when the craft is rolling and/or pitching up to $\pm 10^\circ$, the performance requirements in this standard shall be complied with.

4.11 (IMO MSC ... (72) 5.2.9) Clear view

Arrangement shall be provided to ensure efficient cleaning of the sensor head/lens from the operating position. Administration may require some additional facilities such as de-icing.

4.12 (IMO MSC ... (72) 5.2.10) Optical interference

Measures shall be taken, to ensure that objects commonly encountered at sea and in ports shall not be displayed less clearly on the monitor of the night vision equipment because of dazzle effects, reflection, blooming, or any other effects due to the surroundings.

4.13 IMO MSC ... (72) 5.3) Malfunctions, warnings, alarms and indications

Night vision equipment shall include a visual indication of any failure.

4.14 (IMO MSC ... (72) 5.4) Software requirements

The operational characteristics of the software shall meet the following requirements in particular:

- .1 self-description of the functions implemented by means of software;
- .2 display of user interface status; and
- .3 software protection against unauthorized changes.

If certain functions of night vision equipment are implemented using software, such software shall meet the applicable requirements of IEC 60945.

If any software is used, the manufacturer shall provide a description of the functions implemented by means of software and state how the requirements have been complied with.

“Self-description of the functions implemented by means of software” means that the functions available through menus (or similar) rather than separate controls shall be clear from the menu description.

“User interface status” can be an indicator of which functions are operational.

“Software protection” can be a password or lockable cover.

4.15 (IMO MSC ... (72) 6) Controls and ergonomics

The night vision equipment shall be designed in accordance with sound ergonomic principles.

The number of operational controls shall be limited to the minimum required for operation.

Whilst in operational mode double functions of controls shall be avoided on such controls as for pan, vertical trim, field of view and other essential functions.

The functions of the individual operational controls shall be clearly labelled.

The operational functions of night vision equipment shall be activated directly through the operational controls; menu-driven controls shall be avoided.

The operational controls shall be clearly identifiable in the dark. If illumination is used, the brightness shall be adjustable.

The operational controls of night vision equipment shall meet the requirements of resolution A.694 (17) as well as applicable requirements of IEC 60945.

4.16 (IMO MSC ... (72) 6.3) Presentation of information

The status of operation of the equipment shall be continuously displayed.

The display shall be non-dazzling and non-flickering. The display shall be capable of displaying a visible image of at least 180 mm in diagonal.

The selected field of view, if more than one is provided, (see 4.6) shall be continuously indicated at the operating position.

The image shall be presented on the display with the same aspect ratio as the sensors as default (natural picture).

4.17 (IMO MSC ... (72) 7.1) Durability and resistance to environmental conditions

Night vision equipment shall withstand the environmental conditions specified in resolution A.694 (17) and in IEC 60945. Provisions shall be made, if necessary, to protect the night vision equipment against high light conditions.

4.18 (IMO MSC ... (72) 7.2) Electrical and electromagnetic interference

With respect to electrical and electromagnetic interference, night vision equipment shall meet the requirements of resolutions A.694 (17) and IEC 60945.

4.19 (IMO MSC ... (72) 7.3) Power supply

The power supply of night vision equipment shall meet the requirements of resolution A.694 (17) and IEC 60945.

4.20 (IMO MSC ... (72) 7.4) Installation

Full installation instructions to meet the following requirements of 4.20 shall be included in the documentation (see 4.25).

The controls of night vision equipment shall be installed in the workstation for navigating and manoeuvring, within easy reach of the navigator.

The observation distance from a dedicated display shall not exceed 2,3 times the image diagonal (i. e. a dedicated night vision workstation).

For a general bridge display, the observation distance from the display shall not exceed 8 times the image diagonal, but shall be situated such that observation from a distance of 2,3 times the image diagonal is also possible.

The sensor of the night vision equipment shall be installed in such a way that:

- a) the horizontal panning area required in 4.7 is free of blind sectors up to 30° on either side; and
- b) in the required field of view, in the direction right ahead, visibility of the water's surface for the vertically tilted sensor is not reduced by more than two craft's lengths by the blind angle of own craft.

Night vision equipment shall be installed in such a way that its operation and detection functions are not impaired by head wind and/or true wind up to 100 knots and roll and/or pitch angles up to $\pm 10^\circ$.

Its performance shall not be impaired by vibration occurring during normal craft's operation.

4.21 (IMO MSC ... (72) 7.5) Maintenance

With respect to maintenance, night vision equipment shall meet the requirements of resolution A.694 (17) and IEC 60945. Where the manufacturer requires maintenance at specific periods, an operating hours meter shall be provided.

4.22 (IMO MSC ... (72) 8) Interfacing

Interfaces with other radio and navigation equipment shall meet IEC 61162. A recognized international standard video output for image recording shall be provided.

4.23 (IMO MSC ... (72) 9) Back up and fall back arrangements

In the event of failure of the pan-tilt device, the sensor shall be capable of being fixed in the ahead position while underway.

4.24 (IMO MSC ... (72) 10) Safety precautions

The safety features of night vision equipment shall meet the requirements of resolution A.694 (17) and IEC 60945.

4.25 (IMO MSC ... (72) 11) Marking and identification

Night vision equipment and any ancillary equipment shall be marked clearly and durably with the following data:

- identification of the manufacturer;
- equipment type number or model identification under which it was type tested;
- serial number of the unit; and
- magnetic compass safe distance.

Night vision equipment shall additionally be marked in accordance with the requirements of resolution A.694 (17) and IEC 60945.

4.26 (IMO MSC ... (72) 12) Documentation

Night vision equipment shall be delivered complete with its technical documentation. Such documentation shall include the following information, if applicable:

General information:

- manufacturer;
- type designation;
- general description of equipment; and
- ancillary equipment and description.

Instructions for installation:

- general installation instructions;
- power supply (voltage, power consumption, frequency) and earthing information;
- Identification of exposed or protected equipment.

Operation of equipment:

- description of functions, controls, display;
- description of start-up procedures;
- calibration of equipment and error messages;
- testing capabilities of equipment;
- description of software used and interfaces.

Troubleshooting; maintenance and service:

- special tools required, maintenance material and spare parts (e. g. fuses, spare bulbs);
- equipment care and maintenance on board HSC;
- available services.

Documentation for night vision equipment shall also meet the requirements of resolution A.694 (17) and IEC 60945.

4.27 Environmental requirements

Each item which appears in this clause is a requirement from IMO A.694 (17) as detailed in IEC 60945 and for which a repeatable method of measurement has been defined in Clause 6.

5 General test conditions

5.1 General

Environmental and safety tests shall be carried out first, followed by laboratory tests and sea trials to verify whether the same EUT meets all technical requirements. Where electrical tests are required, they shall be carried out using the normal test voltage as specified in IEC 60945.

Requirements detailed in clause 4 for which a specific test is not detailed, shall be confirmed by a visual check of the equipment or documentation. The manufacturer shall provide a full technical specification for the EUT.

5.2 Normal temperature, humidity and extreme test conditions

Test conditions shall comply with IEC 60945.

6 Environmental tests

6.1 General

Environmental tests are intended to assess the suitability of the construction of the EUT for its intended physical conditions of use. After each environmental test and, if specified, also during the test, the EUT shall comply with the requirements of a performance check. No preconditioning of the equipment shall be necessary.

6.2 Range of environmental tests

6.2.1 Test according to IEC 60945

Night vision equipment shall, as far as applicable, meet the requirements and pass the tests according to IEC 60945.

6.2.2 Roll and pitch test

This test is intended to prove the ruggedness of the system under the ship motions of 4.10.

The EUT shall be mounted on a surface capable of producing a rolling cycle from + 10° to – 10° from the horizontal in 8 seconds. The EUT shall be subject to the rolling cycle for 30 minutes during which a functional performance check of 6.3 shall be performed. The EUT functions shall continue to operate without degradation during the rolling cycle.

The test shall be repeated with the EUT positioned such that a pitching cycle of $\pm 10^\circ$ is produced.

6.2.3 Optical interference

The EUT shall meet the requirements of 4.12 when tested in accordance with 8.4.2.

6.3 Performance check

The performance check is to verify that the EUT is still operational after being subjected to the environmental tests and any other test where it is specified.

The performance check shall ensure that the EUT meets the requirements of:

- re-selection of field of view if available;
- pan range;
- pan speed;
- vertical trim adjustment;
- sensor and display operation.

The equipment shall provide a clear picture of objects consistent with that at ambient conditions.

7 Laboratory tests

7.1 Introduction

Laboratory tests shall be performed with the EUT which has passed the environmental tests specified in Clause 6.

The purpose of these technical tests is to provide a means of performing laboratory controlled tests on all types of night vision equipment. The results of these tests will be used to compare the measured performance to pre-established standards that have been validated via at sea tests to meet the navigational needs for night navigation of HSCs.

The laboratory tests have been developed to measure the various capabilities of the EUT, it shall include man-machine interfaces, displays, mechanical operation, and sensor.

The methods and procedures of the laboratory tests have been derived such that when the results are compared to previous tests results, they will reliably predict the at sea performance of the system.

7.2 Measurement of thermal imaging systems

7.2.1 Thermal imager system

Minimum Resolvable Temperature Difference (MRTD) and/or Minimum Detectable Temperature difference (MDT) shall be measured according to the STANAG 4349 (MAS/186-Land/4349, 19 June 1996). A general description including the number of observers, room and target temperature and other relevant data shall be presented.

Figures from both the horizontal and the vertical measurements shall be recorded in a diagram with the Spatial Frequency (Cycles/mRad), linear scaled, at the horizontal axis and the Temperature Difference ΔT (Degrees), logarithmic scaled, at the vertical axis.

At least four (4) targets shall be measured. In the diagram the desired target shall be plotted at a ΔT of 1 degree. The targets used at the measurement shall have a spatial frequency both larger and equals / smaller than:

Horizontal: Target equivalent Instant Field of View (IFoV_t) = $1,5/600 = 0,0025 \text{ Rad} = 2,5 \text{ mRad}$ or target equivalent frequency (F_{rt}) = $1/\text{IFoV}_t = 1/2,5 = 0,4 \text{ Cys/mRad}$

Vertical: Target equivalent Instant Field of View (IFoV_t) = $0,5/600 = 0,00083 \text{ Rad} = 0,83 \text{ mRad}$ or target equivalent frequency (Fr_t) = $1/\text{IFoV}_t = 1/0,83 = 1,2 \text{ Cys/mRad}$

7.2.2 Range predictions

The following procedure is under consideration for a future edition of this standard and it is recommended that the procedure is followed and the results recorded.

A range prediction calculation shall be performed using a general accepted software model such as Acquire FLIR 92 or the TRM 3 or the attached algorithm, see annex A (informative). The detection probability at 600 m shall be calculated.

The measured MRTD figures and the following input data shall be used:

Different atmospheric constant shall be used for different types of images according to the following:

Cut-on and cut-off wavelength	Atmospheric constant
Mid: 3,2 μm to 5 μm	$\sigma a1 \text{ [km}^{-1}]$ 0,56
Long: 8 μm to 12 μm	$\sigma a2 \text{ [km}^{-1}]$ 0,21

Path length: 0,6 km

Temperature equivalent ΔT : 1,0 (degree)

Three different calculations with the following number of line-pair per target size shall be supplied:

0,66

1,3

1,6

7.3 Active image intensifier systems

7.3.1 Illuminator spectrum

The illuminators shall not interfere with the night vision of the bridge personnel of the HSC or other craft.

In order to protect night vision of the bridge personnel the illuminator shall include optical filters such that light emission in the visible spectrum (450 nm to 650 nm) does not exceed a luminance of 0,2 % (when calculated using the scotopic response of the human eye).

7.3.2 Measurement of active image intensifier systems

The following procedure is under consideration for a future edition of this standard and it is recommended that the procedure is followed and the results recorded.

7.3.2.1 Image intensifier sensor

The image intensifier sensor under test shall be placed on an optical measurement bench in a laboratory capable of controlling the light level (in the same spectrum as used by the illuminators) down to $1 \times 10^{-4} \text{ Lux}$. Such dark tunnels shall have a known record of performance.

The following procedure is used to establish the performance and provide an acuity curve for evaluating the performance.

- a) Arrange one of the systems illuminators with a variety of aperture stops employed: to vary the light level so that it provides the only illumination in the dark laboratory.
- b) Mount the sensor at a fixed range of at least 25 m, such that the acuity chart is in-focus.
- c) Select an acuity chart of 25 %, 40 % and 60 % target contrast. Adjust the aperture stops on the illuminator and determine the limiting spatial frequency of the system, in the dark laboratory for each of the patterns on the Acuity chart.
- d) The incident light level at the chart position shall be measured.
- e) The acuity curve (spatial frequency vs light level) can then be plotted. The spatial frequency axis can be replotted as range by assuming a number of cycles across the target for a detection task at 90 % probability.

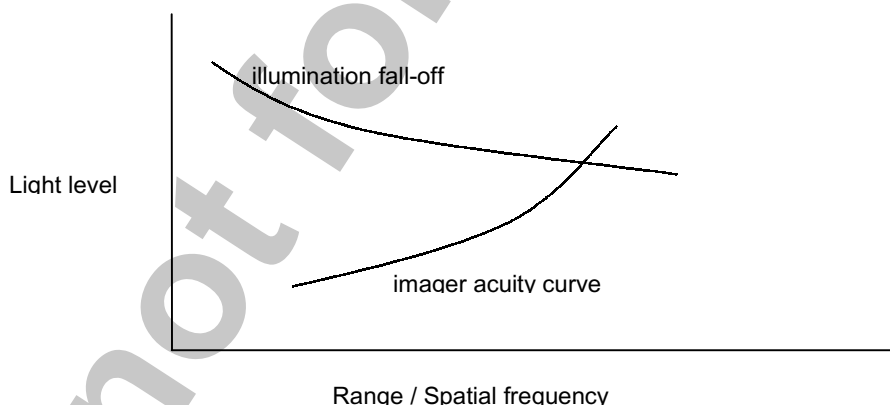
7.3.2.2 Infrared illuminators

The infra-red illuminators used by the system under test shall be placed on an optical measurement bench and the following measurements taken:

- a) The optical spectrum of the light emission;
- b) The intensity of the light emission (this may be taken at any convenient distance). The measured intensity of light emission is used to produce the illumination fall-off curve in 7.3.2.3.
- c) Plots of the horizontal and vertical emission intensity of the illuminator. The light emission (corrected for distance) shall be maintained over at least 20° if the illuminator tracks the sensor head movement. If the illuminator(s) is (are) fixed relative to the crafts heading then the light emission shall be maintained over at least 60°. Combination plots may be used to provide this data if more than one illuminator is declared by the supplier.

7.3.2.3 Range predictions

The imager acuity curve and the illuminator fall-off curve should be plotted. The crossing point of these two curves determines the range performance of the active system.



The extinction coefficient for calculating the illumination fall-off due to atmospheric effects is $\sigma_a = 0,22 \text{ km}^{-1}$. The fall-off due to the "photometric distance law" must be considered additionally (illuminance $\cong 1/R^2$).

Required result:

The point on the curve at which the two curves cross shall show a range equivalence of at least 600 m.

Typical plots are shown in annex B.

7.4 Other technology

At the present time active illuminated intensifier systems and thermal imager systems are available. This section is under consideration for future revisions of this standard for future technologies.

8 Sea trials

8.1 Introduction

Sea trials shall be performed with the same EUT which has passed the environmental tests according to Clause 6 and which has been subjected to laboratory tests according to Clause 7.

Night vision equipment shall pass a sea trial before approval. Test conditions and test results shall be recorded. A suitable report form can be found in annex C (informative). The sea trial shall be conducted at night under normal test conditions (see 8.3), which shall be measured and recorded.

Approval agencies shall maintain a matrix of sea trial results and laboratory test results. Initial input shall be generated using the EUTs sensors to conduct sea trials on various vessels under the defined environmental conditions. During sea trials illuminators shall be used when defined as part of the EUT. The sea trial shall measure the actual performance of the EUT.

NOTE NOTE: The accurate recording of sea trial data may allow future development of a robust laboratory validation process in future editions of this specification.

8.2 Test target for sea trials

The test target for sea trials shall be an enclosed black sea proofed aluminium box of 6 mm thickness which has been immersed in the sea for at least 24 hours. The box shall either be anodised or painted black. If painted, the colour shall not be brighter and the reflection shall not be higher than that of anodised aluminium in the spectral band used by the EUT.

Provisions shall be made to measure the actual temperature at the centre of the test side of the target.

The size of the box is such that when at least 50 % is immersed:

- 1,5 m long;
- 1,5 m wide;
- 0,5 m high;

remains above the water.

Administrations may use other smaller targets to reflect local conditions.

8.3 Test conditions

Sea trials shall be conducted at night under the following test conditions :

- Apparent sea state: 2 to 5, according to the Beaufort-scale;
- Wind speed: 4 kn to 22 kn;
- Sea temperature: 1° C to 25° C;
- Air temperature: 0° C to 35° C;
- Humidity: 40 % to 96 %;

- Natural illumination level: mean starlight conditions without clouds and without moon (5×10^{-4} Lux to $1,3 \times 10^{-3}$ Lux);
- At least 2 hours after sunset;
- Good visibility: not less than 5 NM;
- Speed of vessel: ≥ 8 kn;
- Height of sensor above waterline: 8 m to 10 m.

8.4 Test procedures

8.4.1 General

The test target (as defined in 8.2) shall be immersed in the water at the test side for at least 24 hours such that the approach to the test target can be performed against an open water background.

The sensor of the EUT shall be mounted on the craft used for the sea trials in a height of 8 m to 10 m above the waterline and according to the installation requirements defined in 4.20. Before starting and during the sea trials, the following data shall be measured by using calibrated measurement equipment and recorded:

- Sea temperature;
- Air temperature;
- Humidity;
- Height of sensor above waterline;
- Test target temperature;
- Target-background contrast;
- Barometric pressure;
- Speed over ground of the vessel;
- Natural illumination level;
- Visibility;
- Wind speed.

The following shall be observed and recorded:

- Sea state according to the Beaufort-scale;
- Sky condition;
- Target condition and identification;
- Location of trials.

If the actual conditions are outside the range of the test conditions, no sea trial shall be conducted.

The measurements and observations, including times, shall be recorded in accordance with the form shown in annex C.

8.4.2 Detection range evaluation

The target shall be placed in the test area 24 hours before the test. The craft on which the EUT is installed, shall proceed away from the test target up to a minimum distance of 1 200 m and then proceed with a minimum speed of 8 kn towards the target in such a way, that the target remains within a sector of $\pm 5^\circ$ from the craft's bow.

The target shall be placed in open water with no background sources of interference such that the test can be performed against an open water background. The craft shall approach the target at $90^\circ \pm 10^\circ$ to one of the target faces.

The target shall be observed by the radar operator with radar to measure continuously its actual distance. The observer (or observers) for night vision equipment shall observe the monitor of the EUT and may operate the EUT as usual.

When the target is detected on the monitor, the actual distance of the target shall be measured by the radar operator. The measured data shall be recorded. This procedure shall be repeated ten times. One failure (e. g. detection range less than 600 m with the required field of view) is allowed in 10 times. If two failures occur in the 10 runs, it is permissible to go to a total of 20 runs and if no further failures occur, the EUT has passed.

8.4.3 Optical interference

The craft on which the EUT is installed shall maintain a position 500 m from the test target that shall be within 5 degrees of the craft lubber line. The target shall present a side at $90^\circ \pm 10^\circ$.

A lit vessel (as defined in 3.4) shall proceed at about 5 knots approximately on a bow crossing course with a closest point of approach of 1 500 m.

The observer shall monitor the target during the crossing to confirm that the displayed target remains clearly visible during the crossing.

Annex A

(informative)

Range prediction calculation

Convert “spatial frequency” of MRTD curve into “range (R)” by using following formula.

$$R = \frac{\sqrt{A_t}}{N_{90\%}} f$$

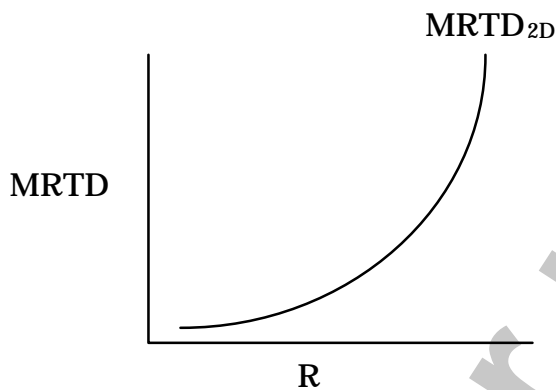
where

f : spatial frequency [cycles/mrad]

R : range [km]

A_t : target area (= 1,5 m x 0,5 m)

$N_{90\%}$: number of line pairs for 90 % detection probability (= 1,3 Lp)



Calculate the target apparent temperature difference (ΔT) by using the following formula, and draw a line of ΔT curve on the MRTD vs. R graph.

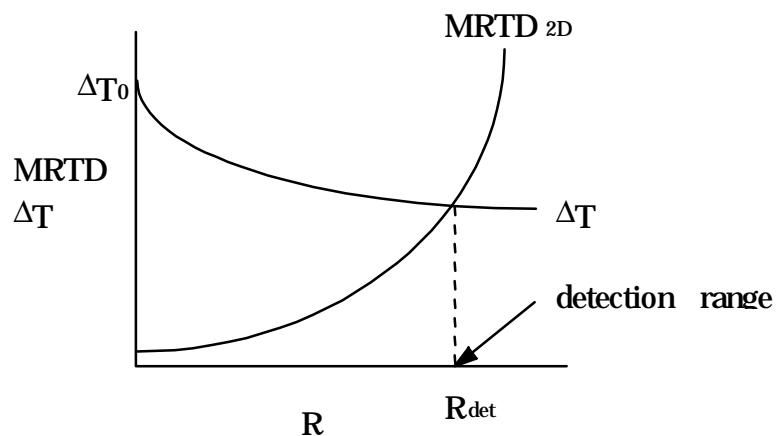
$$\Delta T = \Delta T_0 \exp(-\sigma R)$$

where:

ΔT_0 is the initial temperature difference : 1 (degree)

σ is the atmospheric extinction coefficient:

- 0,56 km⁻¹ for 3,2 to 5 μm systems,
- 0,21 km⁻¹ for 8 to 12 μm systems



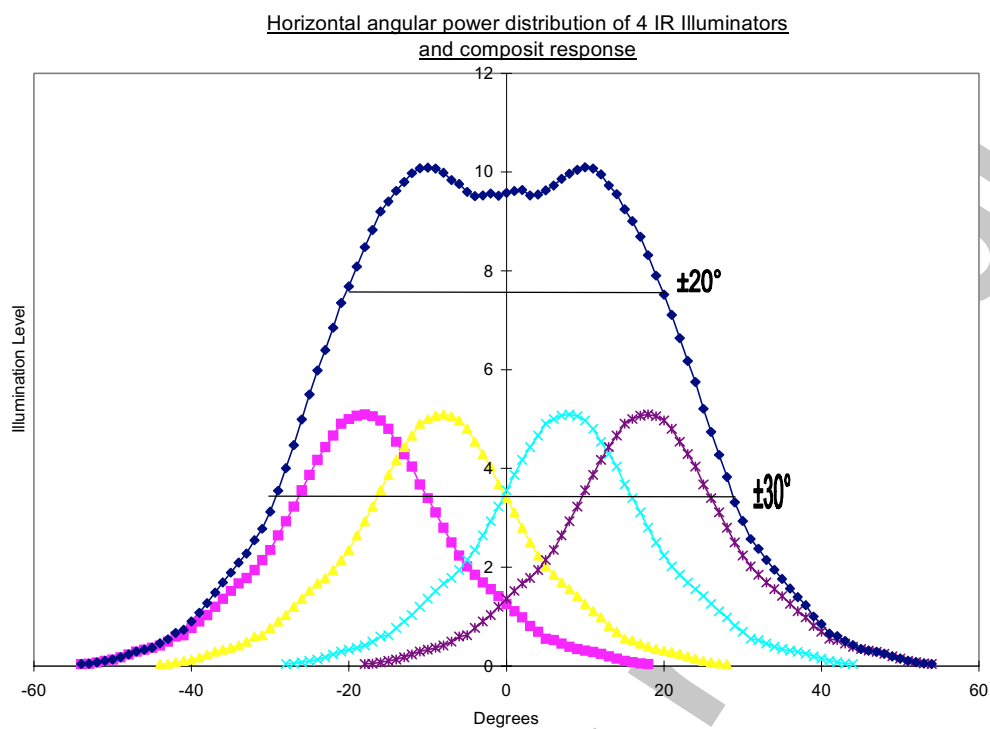
Determine the detection range (R_{det}) by using above graph.

The detection range shall be not less than 0,6 km.

NOTE The number of line pairs for 90 % detection probability ($N_{50\%} = 1,3 \text{ Lp}$) is calculated by $N_{50\%} = 0,75$ according to "Electro-Optical Imaging System Performance" (SPIE Optical Engineering Press).

Annex B

(informative)

Infrared illumination, typical plots

The four illuminators shown in this example are at:

+18°, +8°, -8°, -18°

relative to own craft Heading

Annex C

(informative)

Sea trial record

Company / Applicant.....

Equipment Name

Equipment Type / Class.....

Testing Organisation

Trials Vessel

File Reference.....

1. Equipment Identity

The equipment listed below has been supplied for testing.

1.1 Sensor Head	
Type	
Sensor technology	
Lens / Optic system	
1.2 Display Unit	
Type	
Size	
Monochrome/Colour	
1.3 Illuminators (Only applicable for Active Image Intensifier Systems)	
Type	
Number used	
Position on test vessel	

Remarks/Comments

.....

.....

.....

Accepted for test

Signature..... Date

2. Trial Installation Details

Date of Test

Location of Trials Site

Latitude Longitude

2.1 Trial Vessel	8.4.3.1.1 Detail
Name of Vessel	
Length of Vessel	
Mounting Height of Sensor	
Mounting Height of Illuminators (if fitted)	
Number of Illuminators (if fitted)	

2.2 Test Target	8.4.3.1.2 Detail
Designation / Serial Number	
Size of Face above water	
Test Target Temperature	
Colour of Face	
Nature of surface finish (delete)	Paint / Anodising / Other (state)

2.3 Trial Conditions	8.4.3.1.3 Detail	
	Start of Trial Runs	End of Trial Runs
Air Temperature °C		
Water Temperature °C		
Visibility NM		
Target-background contrast		
Humidity%RH		
Barometric Pressure mB		
Wind Speed kn		
Sea State Bft		
Sky Condition		
Natural Illumination Lux		

Remarks/Comments

.....

.....

.....

3. Detection Range Evaluation (Clause 8.4.2)

3.1	Standard Detection Runs			
Run	Time	Vessel Speed over Ground	Detection Range	Remarks
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

3.2	Second series Detection Runs (If needed)			
Run	Time	Vessel Speed over Ground	Detection Range	Remarks
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				

4. Optical Interference (Clause 8.4.3)

4.1	Crossing Lit Vessel				
Run	Time	Sensor	Confirm target clearly observed J		
			Before crossing	At same bearing	After crossing
1		Static			
2		Static			

Remarks/Comments

.....

.....

Trials complete

Trials engineer Name

Signature..... Date